Milli-Parsec Structure in High-Latitude Molecular Cloud MBM-12

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ABSTRACT

Observations of high-latitude molecular cloud MBM-12 with the OVRO millimeter interferometer show strong evidence that the CO (1-0) emission towards this cloud is highly structured on milliparsec scales. Approximately 10\% of the CO (1-0) single-dish flux measured towards a 120$\arcsec$ region in this cloud can be accounted for by $\sim$5-10 distinct emission cells, or ''clumps,'' which we have imaged. The clumps are marginally resolved by the $5\arcsec\times 4\arcsec$ synthesized OVRO beam, which has a spatial extent of 2 milliparsecs (450 AU) at the 100 pc distance of MBM-12. The average clump linewidth is 0.2 km/s, giving an upper limit of 10 K for the clump kinetic temperature. Collisional excitation of 10 K CO requires that the emitting regions are extremely dense, and thus not in thermal pressure equilibrium with their surroundings. The amplitude of surface brightness fluctuations in the interferometer channel maps, σ has two significant peaks, at -2.2 km/s and 0.4 km/s. In contrast, a single-dish spectrum toward the same field peaks at -1.3 km/s, where fluctuations are undetected. We show that this can only occur if {\it all} of the CO-emitting gas is (1) optically thick and (2) clumped on milliparsec scales, so that the single-dish CO line profile measures the surface filling fraction of clumped gas, ϕ, as a function of radial velocity.